

EVALUATION OF THE PREDICTION OF THE PBL STRUCTURE USING THE NOAA WEATHER-CHEMISTRY FORECASTING MODEL

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Scientific Impact: Improving PBL parameterizations in weather and air-quality prediction models

Reference: <http://www.mmm.ucar.edu/mm5/workshop/ws02/Michelson.pdf>

In this study, meteorological observations taken during the Texas Air Quality Study 2000 are used to evaluate the predictions of the planetary-boundary-layer (PBL) structure by the NOAA coupled weather-chemistry forecasting model. This study focuses on the performance of the PBL parameterizations in the coupled model by comparing the real-time forecasts with the data sets from wind profilers, rawinsondes, and NCAR's Electra aircraft for the high surface ozone episode during the time period of 25-30 Aug 2000. By identifying the weakness of the PBL parameterizations in simulating the observed interaction of local circulation systems (such as the land-sea breeze) and the distribution of chemical species associated with ozone production on the scale of 1 km, this study is expected to yield very useful information on how to improve the PBL parameterizations suitable for air-quality forecasts.

NOAA's coupled weather-chemistry forecasting model combines a modified version of the fifth-generation Penn State/NCAR Mesoscale Model (MM5) and the chemical mechanism of the Regional Acid Deposition Model Version 2. The PBL parameterization scheme of MM5 is a version of the Mellor-Yamada 1.5 order closure scheme with a multi-layer soil model.

The figures shown below are examples of the type of comparisons that were made. It is clear from this comparison that the model possesses a cold bias at low-levels and an easterly wind bias in the lower troposphere. Model-observation comparisons reveal that the PBL is colder than observed when the prevailing low level winds are from the Gulf of Mexico than when the low-level winds are from inland. Other comparisons also indicate that the forecasted land-sea breeze cycle is in good agreement with the wind-profiler observations, but differences do exist in the wind direction and speed. However, the forecasted direction of the nocturnal low-level jet is more easterly than observed. The forecasted PBL mixing layer generally grows faster and deeper compared with observations. We have identified a few key tunable empirical parameters in the PBL parameterization, and plan to optimize them using the micrometeorological observations.

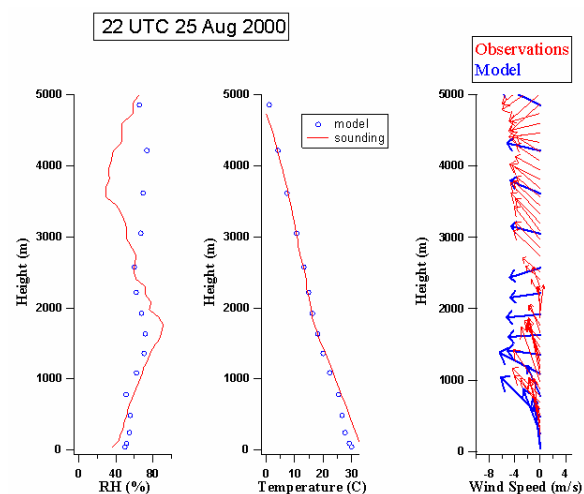


Figure 1. Comparison of the observed and forecasted soundings at 95.54°W 29.5° N.

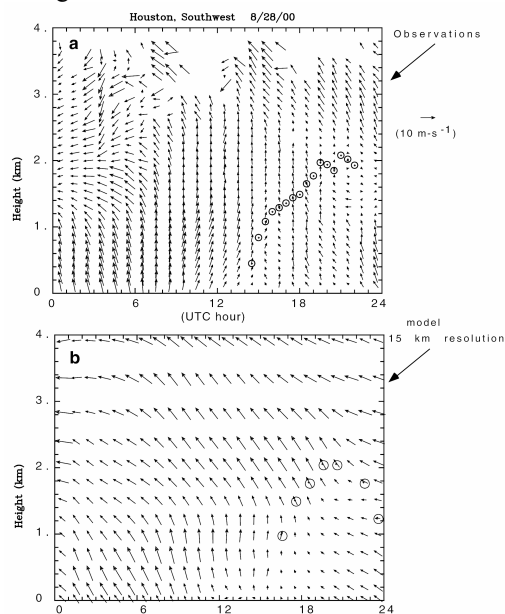


Figure 2. The time-height series of model forecast and wind-profiler observations of the horizontal winds for a 24-h period at southwest Houston (29.54°N, 95.47°W) within the first 4 km above the surface.